SHORT REPORT

# Cost effective use of satellite packs in neonates: importance of birth weight

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**Background:** Blood banks split an adult packed red cell bag (usually 250 ml) into 30 ml bags, making a total of eight neonatal ''satellite'' packs per donor. These packs are then ''allocated''/''committed'' to be used to serially transfuse a newborn.
**Aim:** To study transfusion requirements of premature infants in relation to their birth weight and thereby attempt to rationalise the method of dispensing satellite blood packs.
**Method:** Data on the distribution of neonatal transfusions with respect to weight were obtained retrospectively from unit A (51 infants, 168 transfusions) and unit B (46 infants, 151 transfusions). These data were used to model the effect of different policies on donor exposure and number of unused packs.
**Results:** Infants weighing less than 1000 g at birth have significantly higher transfusion requirements than those weighing1000 g or more ($p = 0.001$ (unit A), $p = 0.004$ (unit B)). Our model predicted a significant reduction in donor exposure if eight packs/infant were allocated to those weighing $<$ 1000 g, and a significant cut in the number of unused packs if four satellite packs/infant were allocated to those weighing $\geqslant$ 1000 g.
**Conclusions:** It would be safer and cost effective to allocate eight packs/infant to those with birth weights $<$ 1000 g and four packs/infant to those with birth weights $\geqslant$ 1000 g.

Low birthweight infants (defined here as birth weight $<$ 1000 g) often require transfusion.[1] Risks associated with transfusions range from mistake in identity (commonest cause of morbidity[2]) and transmission of infection to rare events such as graft versus host disease. The risk of contracting HIV from blood transfusion is less than 1 in a million; however, the risk of contracting variant CJD is not known and is so far entirely theoretical.[2]

Over the past decade we have moved from using whole blood for neonatal top up transfusions to using multiple stored packed cells for serial transfusion. The use of satellite packs has been shown to be safe and reduces donor exposure significantly.[3 4]

Endorsing this view, the Royal College of Paediatrics and Child Health (RCPCH) guidelines[2] on neonatal blood transfusion have recommended that multiple satellite bags from a single donor should be used for serial transfusions to an infant. The guidelines, however, do not specify whether a whole adult bag or a specific number of satellite packs should be allocated to an infant. Allocating fewer than the required number may increase the risk of multiple donor exposure. Conversely, allocating too many will result in wastage of unused satellite packs. Low birthweight infants have higher transfusion requirements because of the need for more intensive care and higher sampling losses in relation to body weight[3 5] than larger infants. Can this information be used to make allocation of satellite units more cost effective? None of the eight tertiary level neonatal units in London that we surveyed consider birth weight when allocating satellite packs.

We studied the distribution of transfusion requirements in relation to birth weight and examined a method of allocation that would minimise donor exposure and wastage of unused satellite packs.

## METHODS

We retrospectively collected data from two neonatal units over a six month period. Unit A (51 infants and 168 transfusions, study period September 1999 to March 2000) was a tertiary level unit, and unit B (46 infants, 151 transfusions, study period February 2000 to August 2000) was a subregional centre. The distribution of the number of transfusions in relation to birth weight was studied. Infants were divided into two groups according to birth weight ($<$ and $\geqslant$ 1000 g), and the number of transfusions given were compared. We excluded infants who had surgical conditions, died, or were transferred to another unit and those who had received recombinant erythropoietin.

The policies on the indications for transfusion differed slightly in the two units. Unit A and unit B both transfused oxygen dependent infants in order to maintain haemoglobin concentration above 130 and 120 g/l respectively. Both units transfused symptomatic (poor weight gain, tachypnoea) infants with haemoglobin concentration below 80 g/l. In asymptomatic infants, the concentration was allowed to fall to 60–80 g/l. The amount of blood transfused per transfusion was 10–20 ml/kg in both units. Unit A allocated eight packs to all infants, whereas unit B did not pre-allocate satellite packs.

We modelled the effect of different methods of allocation (universal allocation of four satellite packs/infant and eight satellite packs/infant, and a differential allocation of eight satellite packs for those weighing less than 1000 g and four satellite packs for those weighing more than 1000 g) on donor exposure and number of unused packs. We based the model on the data collected from units A and B. For the purposes of our model, we assumed that blood was allocated on day 1 of the shelf life of the satellite packs (taken to be 35 days). In practice, the age of the satellite packs may vary and may result in higher rates of donor exposure (across all groups) than predicted. We took into consideration the fact that not all transfusion requirements were met during the shelf life of the satellite pack.

## RESULTS

### Birth weight and transfusions

We analysed the data from 51 infants in unit A and 46 infants in unit B (table 1).

The birth weight and number of transfusions required are negatively correlated (Pearson's coefficient –0.44, $p < 0.001$).

**Table 1** Characteristics of the two units studied

| | Unit A | Unit B |
|---|---|---|
| Number of infants | 51 | 46 |
| Number of transfusions | 168 | 151 |
| Excluded from study | 5 (3 deaths, 2 surgical cases) | 10 (deaths, 3 had fatal surgical conditions) |

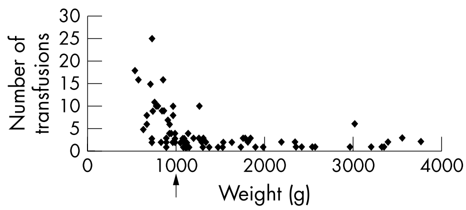


**Figure 1** Birth weight and number of transfusions.

Using a cut off (marked by arrow on fig 1) of 1000 g, we divided the infants into two groups and studied the distribution of the number of transfusions (table 2).

Infants weighing < 1000 g at birth had a significantly higher transfusion requirement (table 2).

Table 3 depicts a model created using data from units A and B, showing the effect of different allocation policies on donor exposure and number of unused packs.

**Table 2** Distribution of the number of transfusions by birth weight

| | Unit A | | Unit B | |
|---|---|---|---|---|
| | <1000 g | ⩾1000 g | <1000 g | ⩾1000 g |
| Total number of infants | 9 | 37 | 16 | 20 |
| Birth weight (g) | 850 (12) | 1840 (75) | 803 (127) | 1870 (91) |
| Total number of transfusions | 94 (55%) | 74 (45%) | 106 (71%) | 45 (29%) |
| Number of transfusions per infant | 8.95 (6.0) | 2 (1.25) | 6.62 (4.5) | 2.25 (1.97) |
| Mean difference (CI) | 6.9 (4.3 to 9.5) | | 4.3 (2.0 to 6.6) | |
| p Value (*t* test) | 0.001 | | 0.004 | |

Values are mean (SD) unless otherwise indicated.

**Table 3** Model showing the effect of different allocation policies on donor exposure and number of unused packs

| | 4 packs/infant | 8 packs/ infant | Difference |
|---|---|---|---|
| Donors/infant (<1000 g) | 2.28 (1.3) | 1.31 (0.69)* | 0.98 (CI 0.52 to 1.5); p<0.0001 |
| Donors/infant (⩾1000 g) | 1.06 (0.3) | 1.02 (0.14) | p=0.413 |
| Unused packs/ infant (<1000 g) | 1.43 (1.13) | 4.27 (2.6) | 2.8 (CI 1.8 to 3.8); p<0.001 |
| Unused packs/ infant (⩾1000 g) | 2.15 (0.85)† | 6.0 (1.15) | 3.86 (CI 3.4 to 4.2); p<0.001 |

Values are mean (SD).
*,†See the Discussion.

## DISCUSSION

We have confirmed that the number of transfusions required and birth weight are inversely related. Although the two units in this study offered different levels of care and differed with regard to the threshold used to transfuse infants, the difference in the transfusion requirements relating to birth weight was significant in both units. Our model (table 3) reflects these differences and predicts that a method of differential allocation of eight packs to infants of birth weight less than 1000 g* and four packs to those of birth weight 1000 g or above† would be most cost effective.

With improvements in neonatal care, transfusion requirements in newborns are falling. Widness *et al*[6] showed that over a 12 year period (1982 to 1993), there was a progressive decline in red blood cell transfusions, donor exposure, and transfusion volumes occurring concurrently with decreases in mortality and morbidity. Most (70%) transfusions were given in the first 4 weeks of life (when infants are sickest). Importantly, although the percentage of infants of birth weight ⩾ 1000 g and never receiving any transfusions increased with time (17% in 1982, 33% in 1989, and 64% in 1993), more than 95% of infants weighing 1000 g or less in all years received transfusions.

Blood transfusion requirements depend on several factors such as level of intensive care required,[5] coexisting morbidity, gestation, age of the infant, and the blood bank policy on transfusions. Often 10–15% of the circulating blood volume in seriously ill neonates is removed for laboratory tests in the first 2 days of life.[7] The major causes of anaemia in small infants are phlebotomy losses and a diminished ability to mount an effective erythropoietin response to the falling red blood cell mass.[8]

Recent improvements in neonatal care have had a significant impact on reducing the number of blood transfusions required. However, the method of dispensing an adult packed cell unit could have significant implications in relation to donor exposure and costs (the material cost of one satellite bag is about £16).

Neonatal units differ considerably in the method of allocation of satellite packs. Centres practising neonatal care should develop their own protocols for transfusions[2] by liaising with their local blood bank and arriving at a consensus on the dispensing of an adult packed cell unit. The number of satellite packs allocated may, however, need to reflect coexisting morbidity.

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